

Electra Mars Proximity-Link Communications and Navigation Payload Description

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Introduction

The Mars Exploration Program (MEP) has identified the need for establishing a robust Mars infrastructure to provide mission-enabling and enhancing telecommunications and navigation services to future MEP elements. To this end, the Program has funded development of a standardized proximity-link communications and navigation payload, known as The Electra UHF Transceiver (EUT), for flight on each science orbiter, starting with the 2005 Mars Reconnaissance Orbiter.

Scout orbiter missions with mission lifetimes of one Mars year or more are required to carry the Electra UHF relay communications payload for feed-forward provision of in-situ telecommunications and navigation services to subsequent MEP missions. The cost of the payload and ground support will be funded by MEP, and these costs are not counted against the overall project cost. In addition, the actual cost of any extended mission operations to support relay services, after the nominal science mission is completed, would also be provided by MEP and would not be counted against the overall project cost. However, the proposing project is responsible for any and all costs associated with integrating the payload into the overall flight system, and for implementing the functional capability within the project mission operation system/ground data system required to operate the payload.

This document provides a high-level description of the Electra payload interfaces to assist proposers in incorporating this payload into their orbiter design. Applicable Scout orbiter proposals shall include the Electra payload in the overall spacecraft block diagram, and include appropriate Electra mass and power allocations in the overall spacecraft design.

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Electra Payload Description

The Electra Payload consists of the Electra UHF Transceiver, an external frequency reference (USO or SSO), a low gain UHF antenna (quad helix or patch) and ancillary cabling and mounting hardware. Table 1 lists the payload elements and masses. The total estimated mass for the single-string payload is 7.4 kg (not to exceed). Accommodation of the payload on the spacecraft requires placement of the UHF low gain antenna such that it can be pointed in the nadir direction, with a clear field-of-view over a cone angle of ± 60 deg relative to the antenna boresight.

Electra Payload Element	Mass (kg)	Volume (cm)
Electra UHF transceiver (EUT)	5.1	21.7l x 20.1w x 12.2h
UHF Low Gain Antenna (including coaxial cable to transceiver)	1.2	23.0 dia x 31.0 h (TBC)
External Oscillator (USO/SSO)	0.8	15.6l x 11.5w x 5.4h
Cabling for payload-spacecraft interfaces	0.3	TBD
TOTAL (Not to Exceed)	7.4	-

Table 1: Electra Payload Elements and Mass/Volume Estimates

The heart of the Electra Payload is the Electra UHF Transceiver (EUT), which is a fully-reconfigurable, frequency-agile transceiver operating in the 390-450 MHz band. The EUT incorporates a modular design with functional elements residing in four stacked modules: a Filtering and Switching Unit (FSU) slice, a Receiver/Modulator (RXA/MOD) slice, a Baseband Processor Module (BPM) slice, and a Power Amplifier-Power Supply Module (P/A-PSM) slice. An isometric view of the MRO EUT is shown in Figure 1. Key EUT specifications are provided in Table 2.

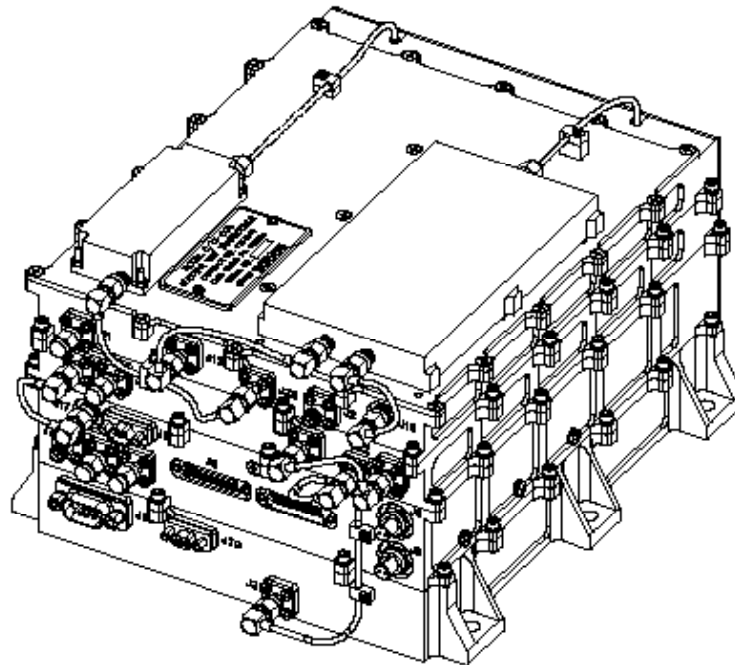


Figure 1: Isometric View of EUT

Parameter	Electra UHF Transceiver
TX Frequency	FD: 435 to 450 MHz; HDO: 390 - 450 MHz
RX Frequency	FD: 390 to 405 MHz; HDO: 390 - 450 MHz
Duplex	Half & Full
Operational Modes	Sleep, Stdby, Rx, Tx, Rx/Tx
TX/RX Rate	1,2,4,8...2048 Ksps
Modulation	Manchester, NRZ-L, BPSK, QPSK Mod Index 60 & 90
Coding	Reed Solomon, K=7, R=1/2 Conv Encode/Decode
Spectrum Record	Open Loop Signal Sampling < 100 KSPS, 1-8 bits/sample
RX Noise Figure	FD: 4.9 dB; HDO: 3.9 dB
RF TX Power	FD: 5.0 W; HDO: 7.0W
Protocols	Proximity-1
Reconfigurability	Yes
Doppler Obs	1-way/2-way
Mass	5005 gms (w/Diplexer)
Dimensions (l,w,h)	21.7 cm × 20.1 cm × 11.6 cm
DC Power -Sleep Mode	7.2W (WC, EOL)
DC Power - RX Mode	23.8 W (WC, EOL)
DC Power - TX/RX Mode	75.3 W (WC, EOL)
Parts Grade	B+
TID	20 Krad

Table 2: Key EUT Specifications

The Electra payload has a number of interfaces with elements of the spacecraft bus, including the spacecraft command and data handling subsystem and the spacecraft power subsystem. These interfaces are summarized in Table 3. The worst case, EOL power consumption estimate for the payload is summarized in Table 4 (over temperature, age, radiation). Note that Payload DC power consumption values assume use of the MRO USO – Payload power consumption will vary if another external oscillator is used.

Electra Payload Interface	Description
Command and control	Redundant, cross-strapped 1553-B physical interface with 1553 protocol
Proximity link data (Forward and Return)	High-Speed Low Voltage Differential Signaling (HS-LVDS)
DC power	28 VDC
1 Pulse-Per-Second (1 PPS) timing	Direct analog line
Power-on-Reset (POR)	Direct analog line

Table 3: Electra Payload – Spacecraft Bus Interfaces

Electra Payload Operating Mode	DC Power (W)
Full-duplex (transmit/receive)	82.5
Receive-only	31.1
Sleep	14.5

Table 4: Electra Payload Power Consumption (Worst case, EOL)

Figure 2 depicts a simplified block diagram of the Electra Payload, highlighting the primary payload elements and payload interfaces with the spacecraft bus.

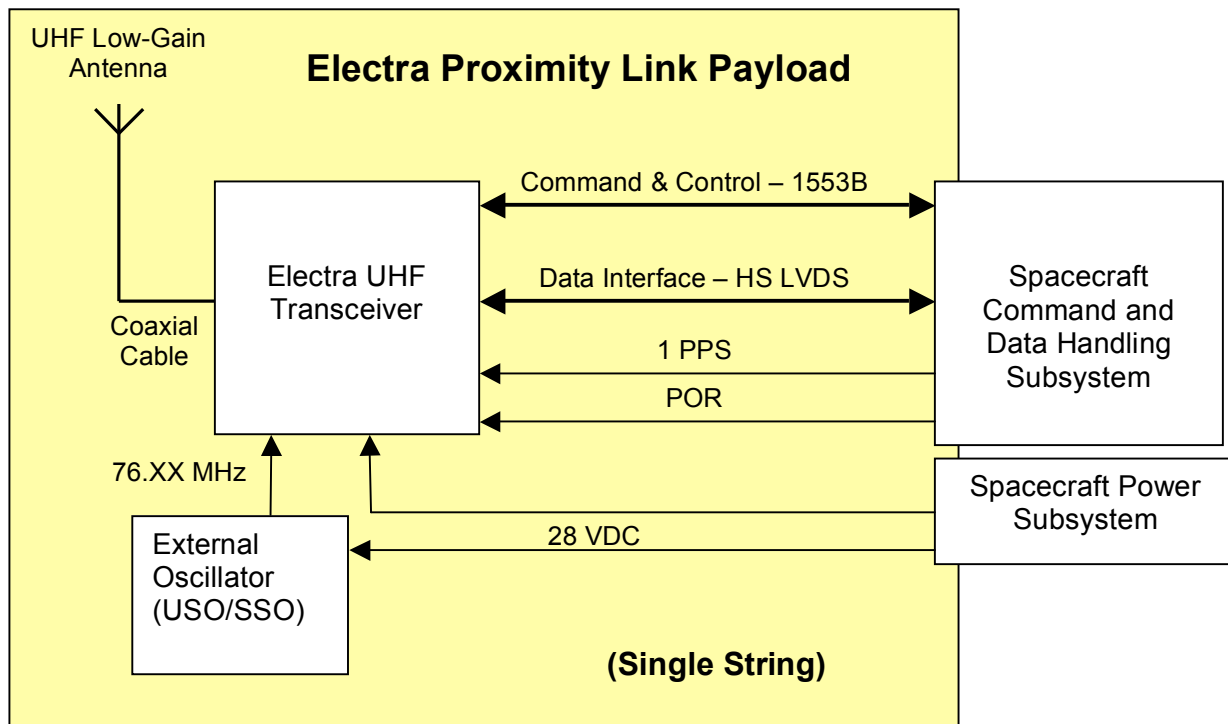


Figure 2: Electra Proximity Link Payload block diagram